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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Docket No.: 23438.00023

Box PATENT APPLICATION
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NEW UTILITY PATENT APPLICATION

Commissioner:

Herewith is the utility patent application of Applicant:

Paul V. Cooper

TITLE: SCRAP MELTER AND IMPELLER THEREFORE

Including:

- ☐ Declaration
- ☒ Abstract
- 11 Pages of Specification (only specification and claims)
- 30 Numbered claims(s)
- 6 Sheets of drawing: ☒ informal ☐ formal
- ☐ This is a filing under 37 C.F.R. §1.47 (Petition attached)
- ☐ Attached is an Assignment to _____
- ☐ Attached: Assignment Recordation Cover Sheet
- ☐ Attached: Statement(s) establishing "small entity" status under 37 C.F.R. §§1.9 and 1.27
- ☐ Attached: Information Disclosure Statement pursuant to 37 C.F.R. §§1.97-1.99
- ☐ Attached: Form PTO No. 1449
- ☐ Attached: Preliminary Amendment
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THE FOLLOWING FILING FEE IS BASED ON CLAIMS AS FILED
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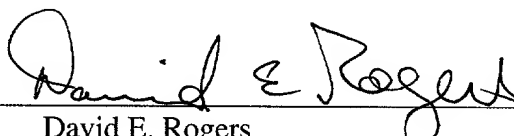
	Claims filed		Basic claims		Present Extra		Fees
Basic Fee:							\$ 690.00
Total Effective Claims	30	minus	20	=	10	x \$ 18.00	= 180.00
Independent Claims	5	minus	3	=	2	x \$ 78.00	156.00
						Subtotal	= \$1026.00
If "small entity" status box above is checked, enter half (1/2) of Subtotal and subtract							513.00
TOTAL FILING FEE							= \$513.00
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Respectfully submitted,

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s) Paul V. Cooper Docket No.: 23438.00023
Application No.: Group Art Unit: Unknown
Filing Date: August 28, 2000 Examiner: Not yet assigned
TITLE SCRAP MELTER AND IMPELLER THEREFORE

STATEMENT (DECLARATION) CLAIMING
SMALL ENTITY STATUS UNDER 37 C.F.R. §§1.9(f) AND 1.27(b)—
INDEPENDENT INVENTOR(S)

Commissioner for Patents
Washington, DC 20231

Commissioner:

As the below-named inventor, I hereby declare that I am qualified as an independent inventor as defined in 37 C.F.R. §1.9(c) for purposes of paying reduced fees under Section 41(a) and (b) of Title 35, United States Code, to the Patent and Trademark Office with regard to the invention entitled:

SCRAP MELTER AND IMPELLER THEREFORE

described in:

☒ the specification filed herewith

☐ application no. _____, filed _____

☐ patent no. _____, issued _____

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I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 C.F.R. §1.28(b)).

I hereby declare that all statements made herein are of my own knowledge, are true and that all statements made on information and belief are believed to be true; and further, that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

Paul V. Cooper
NAME OF INVENTOR

Signature of Inventor

Date

SCRAP MELTER AND IMPELLER THEREFORE

FIELD OF THE INVENTION

The present invention relates to a device, called a scrap melter, for submerging scrap metal in a molten metal bath. The device preferably includes a drive source, an impeller and a drive shaft. The device preferably draws molten metal downward in order to submerge scrap placed on the surface of the bath.

BACKGROUND OF THE INVENTION

Scrap melter systems, such as the one shown schematically in Figs. 1 and 2, generally use two devices, a circulation pump and a scrap melter. As shown in Fig. 1 the vessel V containing molten metal bath B is preferably divided into two compartments. Compartment 1 (called a pump well) houses circulation pump 2. Compartment 3 (called a charge well) houses a scrap melter 10. The circulating molten metal moves between compartment 1 and compartment 3 and is preferably circulated throughout vessel V. Scrap S is introduced into compartment 3 and is submerged by the downward draw created by the impeller of scrap melter 10, which pulls the scrap downward into the molten metal bath. The molten metal bath is preferably maintained, at least partially, in a remelting furnace having a heating chamber interconnected to a melting chamber. Bath B is maintained at a temperature above the melting point of the scrap metal in order to melt the scrap metal.

A conventional scrap melter includes an impeller affixed to a drive shaft, and a drive source for rotating the shaft and the impeller. As stated above, the impeller draws molten metal and the scrap metal downward into the molten metal bath in order to melt the scrap. The circulation pump is preferably positioned in the pump well and circulates the molten metal between the chambers in order to maintain a relatively constant temperature within bath B. Such a system, including a circulation pump and a scrap melter, is disclosed in U.S. Patent 4,598,899, issued July 8, 1986 to Cooper, the disclosure of which that is not inconsistent with this disclosure is incorporated herein by reference. As defined herein, the terms auger, rotor and impeller refer to the same general structure, i.e., a device used in a scrap melter for displacing molten metal.

Scrap melter impellers generally move molten metal radially outward away from the impeller to create a downward draw above the impeller. However, such impellers can create

turbulence or flow that may partially move into the path of the fluid entering the impeller from above, in which case some scrap may not be efficiently drawn into bath B where it can be melted and mixed, thus decreasing the fluid flow to the impeller and decreasing the efficiency of the scrap melting operation. In addition, the radial turbulence may cause some fluid that has been expelled from the impeller to be immediately recirculated through the impeller, thus decreasing the flow of virgin fluid through the impeller. That further decreases efficiency because it reduces the draw of molten metal from above the impeller. As a result, in order to maintain a desired volume of fluid flow through the impeller, the speed of the impeller may be increased to overcome these effects. Increasing the speed of the impeller, however, may cause excess vibration leading to part failure, downtime and maintenance expenses.

Scrap melters have been developed to restrict radial flow from the impeller to limit turbulence and produce more efficient flow. One such assembly, disclosed in U.S. patent 4,930,986, issued June 5, 1990 to Cooper, the disclosure of which that is not inconsistent with this disclosure is incorporated herein by reference, includes an impeller positioned inside a drum, both of which rotate as a single unit. One disadvantage to this assembly is that pieces of scrap or dross can jam in it, which decreases its efficiency. Other prior art devices are disclosed in U.S. Patent Nos. 4,286,985, 3,984,234, 4,128,415 and 4,322,245.

Summary of the Invention

The preferred embodiment of the present invention is a scrap melter utilizing an open impeller to reduce jamming or clogging. Thus, the invention can function efficiently in virtually any scrap melting environment, handling particles of virtually any size that are likely to be encountered in any such environment. An impeller according to the invention functions by displacing molten metal to create a downward draw. It provides the benefit of reducing the problems associated with faster operating speeds (i.e., the possible creation of a vortex and turbulence, and/or part failure, greater downtime and higher maintenance costs). The way in which it achieves these results is by (a) displacing more molten metal while operating at the same speed as conventional impellers, and/or (b) moving at least some of the molten metal in a downward or partially downward direction.

An impeller according to the invention displaces more molten metal by the use of (1) a larger area on the blade surfaces that push against the molten metal as the impeller rotates, and/or (2) surfaces that push against the metal at angles that displace a relatively large amount of molten

metal. One impeller according to the invention preferably moves molten metal at least partially in the downward direction, while another moves molten metal only in an outward direction.

In one preferred embodiment the impeller is preferably a four-bladed cross wherein each blade preferably includes an angled surface that directs molten metal at least partially in the downward direction. The impeller creates a draw that draws molten metal and any solid scrap metal contained therein downward into the molten metal bath. It also preferably provides at least some radial or partially radial flow, and may include a surface or structure specifically designed to generate radial or partially radial flow, to assist in circulating molten metal within the bath.

In another preferred embodiment, the impeller is preferably a four-bladed cross wherein each blade preferably includes a vertical surface that directs molten metal radially outward away from the impeller. The impeller creates a draw that draws molten metal and any solid scrap metal contained therein downward into the molten metal bath. It also assists in circulating molten metal within the bath.

A scrap melter according to the invention can be operated at lower speeds than conventional melters but still displace the same amount of molten metal per impeller revolution. Alternatively, it can be operated at the same speeds as, and displace more molten than conventional scrap melters. A benefit of the lower speed is that the scrap melter of the invention vibrates less and requires less maintenance and fewer replacement parts.

A preferred melter according to the invention includes a drive source, a drive shaft having a first end and a second end and an impeller. The first end of the drive shaft is connected to the drive source. An impeller according to the invention is connected to the second end of the drive shaft. The drive source is preferably a pneumatic or electric motor, but can be any device(s) capable of rotating the impeller.

A scrap melter according to the invention may be used in a scrap melter system comprising a scrap melter, a vessel containing a molten metal bath and a circulation pump. Conventional pumps for pumping molten metal that may be used as circulation pumps are generally disclosed in U.S. Patent No. 2,948,524 to Sweeney et al., U.S. Patent No. 5,203,681 to Cooper entitled "Submersible Molten Metal Pump," pending U.S. Application Ser. No. 08/759,780, filed December 13, 1996, entitled Molten Metal Pump With a Flexible Coupling and Cement-Free Metal-Transfer Conduit Connection, U.S. Patent No. to Cooper entitled Impeller Bearing System for Molten Metal Pumps, U.S. Application Ser. No. 09/152,168, filed Sept. 11,

1998, entitled Improved Gas Dispersion Device, U.S. Patent No. 5,678,807 to Cooper and U.S. Patent No. 5,662,725 to Cooper, the disclosures of which are incorporated herein by reference.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the present invention will now be described with reference to the drawings, wherein like designations denote like elements, and:

Figure 1 is a side view of a scrap melter system according to the invention comprising a scrap melter, a vessel and an impeller according to the invention.

Figure 2 is a top view of the system shown in Fig. 1.

Figure 3 is a perspective view of a preferred impeller according to the invention.

Figure 4 is perspective view of an alternate preferred impeller according to the invention.

Figure 5 shows an exploded, perspective view of an assembly according to the invention, including a drive shaft, the impeller of Fig. 3 and a nut.

Figure 6 is a partial side view of the assembly shown in Fig. 5, showing the connected components.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring now to the figures, where the purpose is for describing a preferred embodiment of the invention and not for limiting same, Fig. 1 shows a scrap melter 10 submerged in a molten metal bath B. All of the components of scrap melter 10 exposed to molten metal bath B are preferably formed from oxidation-resistant graphite or other material suitable for use in molten metal.

A drive source 28 is connected to impeller 100 by any structure suitable to transfer driving force from source 28 to impeller 100. Drive source 28 is preferably an electric, pneumatic or hydraulic motor although, as used herein, the term drive source refers to any device or devices capable of rotating impeller 100.

A drive shaft 12 is preferably comprised of a motor drive shaft (not shown) connected to an impeller drive shaft 40. The motor drive shaft has a first end and a second end, the first end being connected to motor 28 by any suitable means and which is effectively the first end of drive shaft 12 in the preferred embodiment. An impeller shaft 40 has a first end 42 (shown in Fig. 4) and a second end 44. The preferred structure for connecting the motor drive shaft to impeller

drive shaft 40 is a coupling (not shown). The coupling preferably has a first coupling member and a second coupling member. The first end 42 of impeller shaft 40 is connected to the second end of the motor shaft, preferably by the coupling, wherein the first end 42 of impeller shaft 40 is connected to the second coupling member and the second end of the motor drive shaft is connected to the first coupling member. The motor drive shaft drives the coupling, which, in turn, drives impeller drive shaft 40. Preferably, the coupling and first end 42 of the impeller shaft 40 are connected without the use of connecting threads.

Impeller 100 is an open impeller. As used herein the term open refers to an impeller that allows dross and scrap to pass through it, as opposed to impellers such as the one shown in U.S. Patent No. 4,930,986, which does not allow for the passage of much dross and scrap, because the particle size is often too great to pass through the impeller. Preferred impeller 100 is best seen in Fig. 3. Impeller 100 provides a greater surface area to move molten metal than conventional impellers. Impeller 100 is preferably imperforate, has two or more blades, is preferably formed of solid graphite, is attached to and driven by shaft 12, by being attached to shaft 40 in the preferred embodiment, and is preferably positioned centrally about the axis of shaft 40. Impeller 100 may, however, have a perforate structure (such as a bird-cage impeller, the structure of which is known to those skilled in the art) or partially perforate structure, and be formed of any material suitable for use in a molten metal environment.

Impeller 100 most preferably has four blades 102 and is shaped like a cross when viewed from the top. Impeller 100 includes a central section, or hub, 104 that is the area defined by the intersection between blades 102, when impeller 100 has three or more blades. In the preferred embodiment, hub 104 is an approximately 8" square. A connective portion 106 is preferably a nonthreaded, tapered bore extending through hub 104, but can be any structure capable of connecting impeller 100 to drive shaft 12. The preferred embodiment of impeller 100 also has a top surface 112, a bottom surface 114, and a trailing face 116. The diameter of connective portion 106 is approximately 5" at upper surface 112 and tapers to approximately 4" at lower surface 114 to form a tapered bore as shown in Figs. 3 and 5.

The height of surface 116, measured vertically, is preferably between 6 and 7 inches. Each blade 102 preferably extends approximately 10" outward from hub 104, the overall preferred length and width of impeller 100, including hub 104, therefore being approximately 28". A recess (not shown) may be formed from top surface 112 to trailing surface 116.

Preferably, each blade 102 has the same configuration so only one blade 102 shall be described. In the preferred embodiment, blade 102 has a leading face 108. Face 108 is on the leading side of blade 102 as it rotates (as shown impeller 100 is designed to rotate in a clockwise direction). Face 108 includes an angled portion 108A and a vertical lip 108B. Portion 108A directs molten metal at least partly in the downward direction, toward the bottom of vessel V, as shown in Fig. 1. Surface 108A may be substantially planar or curved, or multi-faceted, such that, as impeller 100 turns, surface 108A directs molten metal partially in the downward direction. Any surface or structure that functions to direct molten metal downward or partially downward can be used, but it is preferred that surface 108A is formed at a 30°-60°, and most preferably a 45° planar angle. Alternatively, leading face 108 may itself be, or include a surface that is, (1) vertical, (2) substantially vertical, or (3) angled to direct molten metal in a partially upward direction, because the radial displacement of molten metal alone will create a downward draw in the space above impeller 100.

Impeller 300, shown in Fig. 4, is also an open impeller. Preferred impeller 300 is best seen in Fig. 4. Impeller 300 also provides a greater surface area to move molten metal than conventional impellers. Impeller 300 is preferably imperforate, has two or more blades, is preferably formed of solid graphite, is attached to and driven by shaft 12, by being attached to shaft 40 in the preferred embodiment, and is preferably positioned centrally about the axis of shaft 40. Impeller 100 may, however, have a perforate structure (such as a bird-cage impeller, the structure of which is known to those skilled in the art) or partially perforate structure, and be formed of any material suitable for use in a molten metal environment.

Impeller 300 most preferably has four blades 302. Impeller 300 includes a central section, or hub, 304 that is the area defined by the intersection between blades 302, when impeller 300 has three or more blades. In the preferred embodiment, hub 304 is an approximately 8" square. A connective portion 306 is preferably a nonthreaded, tapered bore extending through hub 304, but can be any structure capable of connecting impeller 300 to drive shaft 12. The preferred embodiment of impeller 300 also has a top surface 312, a bottom surface 314, and a trailing face 316. The diameter of connective portion 306 is approximately 5" at upper surface 312 and tapers to approximately 4" at lower surface 314 to form a tapered bore as shown in Fig. 4.

The height of surfaces 308, 316, measured vertically, is preferably between 6 and 7 inches. Each blade 302 preferably extends approximately 10" outward from hub 304, the overall preferred length and width of impeller 300, including hub 304, therefore being approximately 28". A recess (not shown) may be formed from top surface 312 to trailing surface 316.

5 Preferably, each blade 302 has the same configuration so only one blade 302 shall be described. In the preferred embodiment, blade 102 has a leading face 308. Face 308 is on the leading side of blade 302 as it rotates (as shown impeller 300 is designed to rotate in a clockwise direction). Face 308 is vertical (as used herein, the term vertical refers to any vertical or substantially vertical surface) and directs molten metal outward away from impeller 300. Face 10 308 may be substantially planar or curved, or multi-faceted, such that, as impeller 300 turns, face 308 directs molten metal outward. Any surface or structure that functions to direct molten metal outward can be used, but it is preferred that surface 308 is vertical and extends the full height of blade 308 so that blade 308 has a square cross section. Alternatively, face 308 may itself be, or include a surface that is angled to direct molten metal in a partially upward direction, because the 15 radial displacement of molten metal alone will create a downward draw in the space above impeller 300.

As shown in Figs. 5 and 6, second end 44 of impeller drive shaft 40 preferably has a tapered section 44A that is received in the tapered bore of the preferred embodiment of connecting portion 106. End 44 also preferably has a threaded section 44B that extends below 20 bottom surface 114 of impeller 100 when section 44A is received in connecting portion 106. In this preferred embodiment, a nut 200, that has a threaded opening 202, is screwed onto section 44B to retain impeller 100 on end 44 of rotor drive shaft 40. Nut 200 and section 44B preferably have 4" - 4 1/2" U.N.C. threads. Nut 200 is preferably a hex head nut having an overall diameter of approximately 7".

25 The purpose of tapered bore 106 is easy removal of end 44 of shaft 40 from connective portion 106. Some prior art devices utilize either a threaded bore and/or a right cylindrical bore, i.e., a bore having the same diameter at the top and bottom to connect the drive shaft to the impeller. The problem with such structures is that during operation of the scrap melter molten metal seeps between the end of the shaft and the bore in the impeller. This leads to difficulty in 30 removing the shaft from the bore, and often the shaft must be chiseled out. The nonthreaded, tapered bore 106 of the invention alleviates this problem. Although only the preferred

attachment of impeller 100 is shown, impeller 300 would preferably be attached to shaft 12 in the same manner as described for impeller 100.

5 Preferred embodiments having now been described, variations that do not depart from the spirit of the invention will occur to others. The invention is thus not limited to the preferred embodiment but is instead set forth in the following claims and legal equivalents thereof, which are contemplated to cover any such variations. Unless specifically stated in the claims, any of the claimed inventions may include structures or devices other than those specifically set forth in the claims.

1 What is claimed is:

2 1. A device for generating a downward stream of molten metal, the device including:

3 (a) a drive source;

4 (b) a drive shaft having a first end and a second end, the first end connected to the
5 drive source; and

6 (c) an impeller connected to the second end of the drive shaft, the impeller having
7 two or more outwardly extending blades, at least one blade including a portion
8 that directs molten metal at least partially downward.

1 2. The device of claim 1 wherein the impeller has four blades.

1 3. The device of claim 1 wherein a connective portion is formed in the impeller, the
2 connective portion connecting the impeller to the drive shaft, the connective portion
3 comprising a tapered, nonthreaded bore extending through the impeller.

1 4. The device of claim 3 which further includes a nut and wherein the second end of the
2 drive shaft has a threaded section that is positioned beneath the impeller; the nut being
3 threaded onto the threaded section to connect the impeller to the drive shaft.

4 5. The device of claim 1 wherein the portion that directs molten metal at least partially
5 downward is an angled surface.

6 6. The device of claim 1 wherein each blade includes a portion that directs molten metal at
7 least partially downward.

1 7. The device of claim 1 wherein the impeller has an overall length of at least 28".

2 8. The device of claim 2 wherein the impeller has an overall length of at least 28" and an
3 overall width of at least 28".

4 9. The device of claim 1 wherein each blade has a height of between 6" and 7".

1 10. The device of claim 5 wherein the angled surface is formed at a 45° angle.

1 11. A device for melting scrap metal, the device comprising:

2 (a) a vessel containing molten metal; and

3 (b) a scrap melter positioned in the vessel, the scrap melter comprising:

4 (i) a drive source;

5 (ii) a drive shaft having an first end and a second end, the first end being
6 connected to the drive source; and

7 (iii) an impeller connected to the second end of the drive shaft, the impeller
8 having two or more outwardly extending blades, at least one of the blades
9 including a portion that directs molten metal at least partially downward.

1 12. The device of claim 11 that further includes a circulation pump positioned in the vessel.

1 13. The device of claim 11 wherein the portion that directs molten metal at least partially
2 downward is an angled surface.

3 14. The device of claim 13 wherein the angled surface is formed at a 45° angle.

1 15. The device of claim 11 wherein the impeller has four blades.

1 16. The device of claim 15 wherein the impeller further includes a hub and each blade
2 extends outward from the hub by at least 10".

3 17. The device of claim 11 wherein each blade has a height between 6" and 7".

4 18. The device of claim 11 wherein the vessel has two compartments.

1 19. An impeller for use in a molten metal bath, the impeller comprising:

2 (a) means for connecting the impeller to a shaft, and

3 (b) means for generating a flow of molten metal.

1 20. The impeller of claim 19 wherein the means for connecting is a tapered, nonthreaded
2 bore extending through the impeller.

1 21. The impeller of claim 19 wherein the means for generating a flow of molten metal is two
2 or more blades formed on the impeller and extending outwardly from a hub, at least one
3 of the blades having a portion for directing molten metal at least partially downward.

1 22. The impeller of claim 21 wherein there are four blades and the impeller further includes a
2 hub.

- 1 23. The impeller of claim 21 wherein at least one of the portions for directing molten metal at
2 least partially downward is an angled surface.
- 1 24. The impeller of claim 22 wherein each of the blades extends outward from the hub by at
2 least ten inches.
- 1 25. A drive shaft used in a device for displacing molten metal, the drive shaft comprising:
2 (a) a first end; and
3 (b) a second end, the second end configured to connect to an impeller and having a
4 tapered portion and a threaded portion juxtaposed the tapered portion
5 whereby the threaded portion is positioned beneath the impeller when the drive shaft is
6 connected to the impeller.
- 1 26. A device for generating a downward stream of molten metal, the device including:
2 (c) a drive source;
3 (d) a drive shaft having a first end and a second end, the first end connected to the
4 drive source; and
5 (e) an impeller connected to the second end of the drive shaft, the impeller having
6 two or more outwardly extending blades, at least one blade including a vertical
7 face that directs molten metal at outward from the impeller.
- 1 27. The device of claim 26 wherein the impeller has four blades.
- 1 28. The impeller of claim 27 wherein the impeller is in the shape of a cross.
- 1 29. The device of claim 26 wherein the vertical face of each blade is at least 6 inches in
2 height.
- 1 30. The device of claim 26 wherein the vertical face of each blade is more than 4 inches in
2 height.

ABSTRACT

A device for submerging scrap metal includes: (a) a drive source, (b) a drive shaft having a first end and a second end, the first end being connected to the drive source, and (d) an impeller connected to the second end of the drive shaft, the impeller preferably having two or more outwardly-extending blades. Preferably, each of the blades has a portion that directs molten metal at least partially downward. The impeller design leads to lower operating speeds, lower vibration, longer component life and less maintenance. Additionally, the impeller preferably has a connective portion. The connective portion is used to connect the impeller to the shaft and preferably comprises a nonthreaded, tapered bore extending through the impeller.

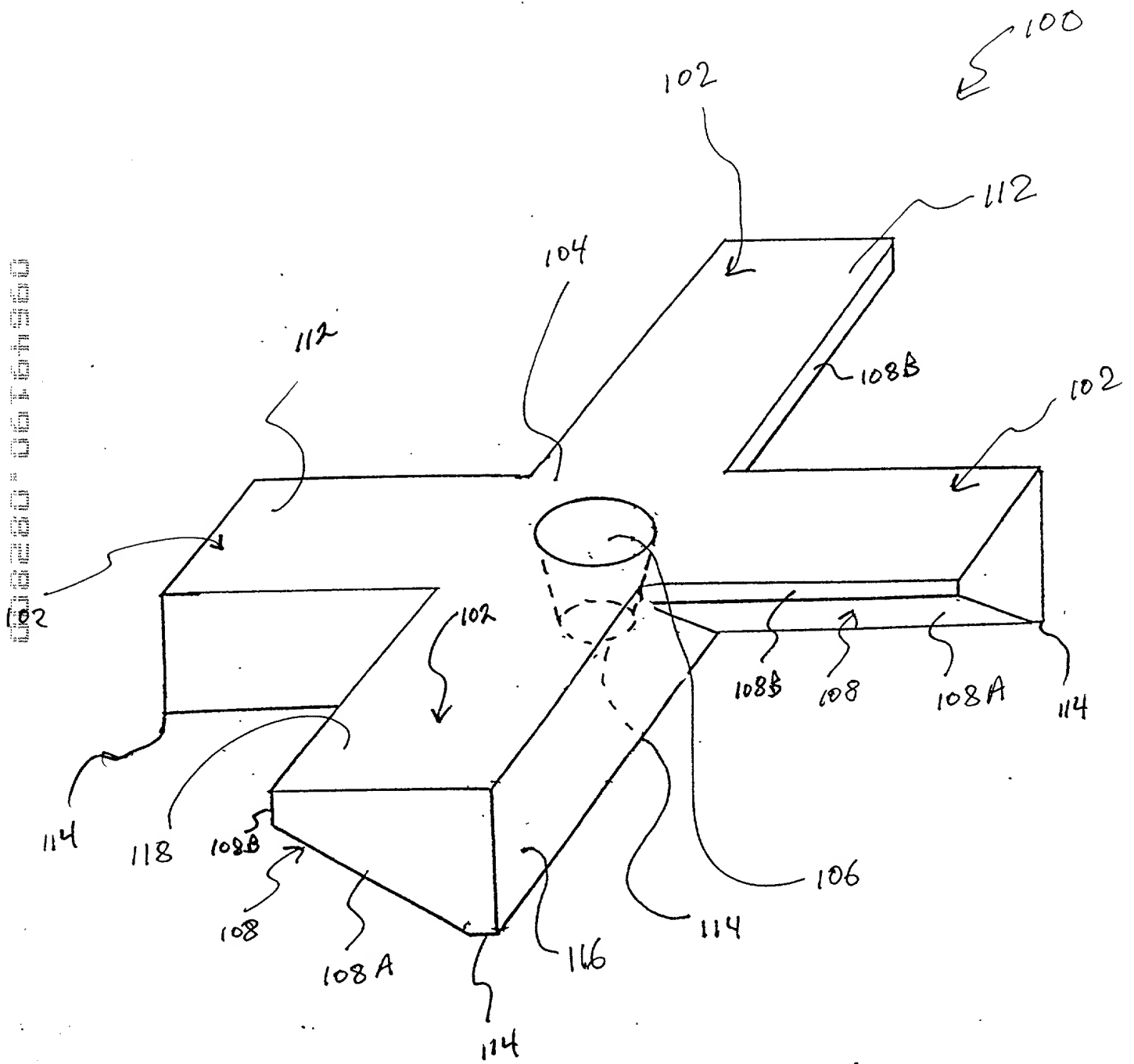


Fig. 3

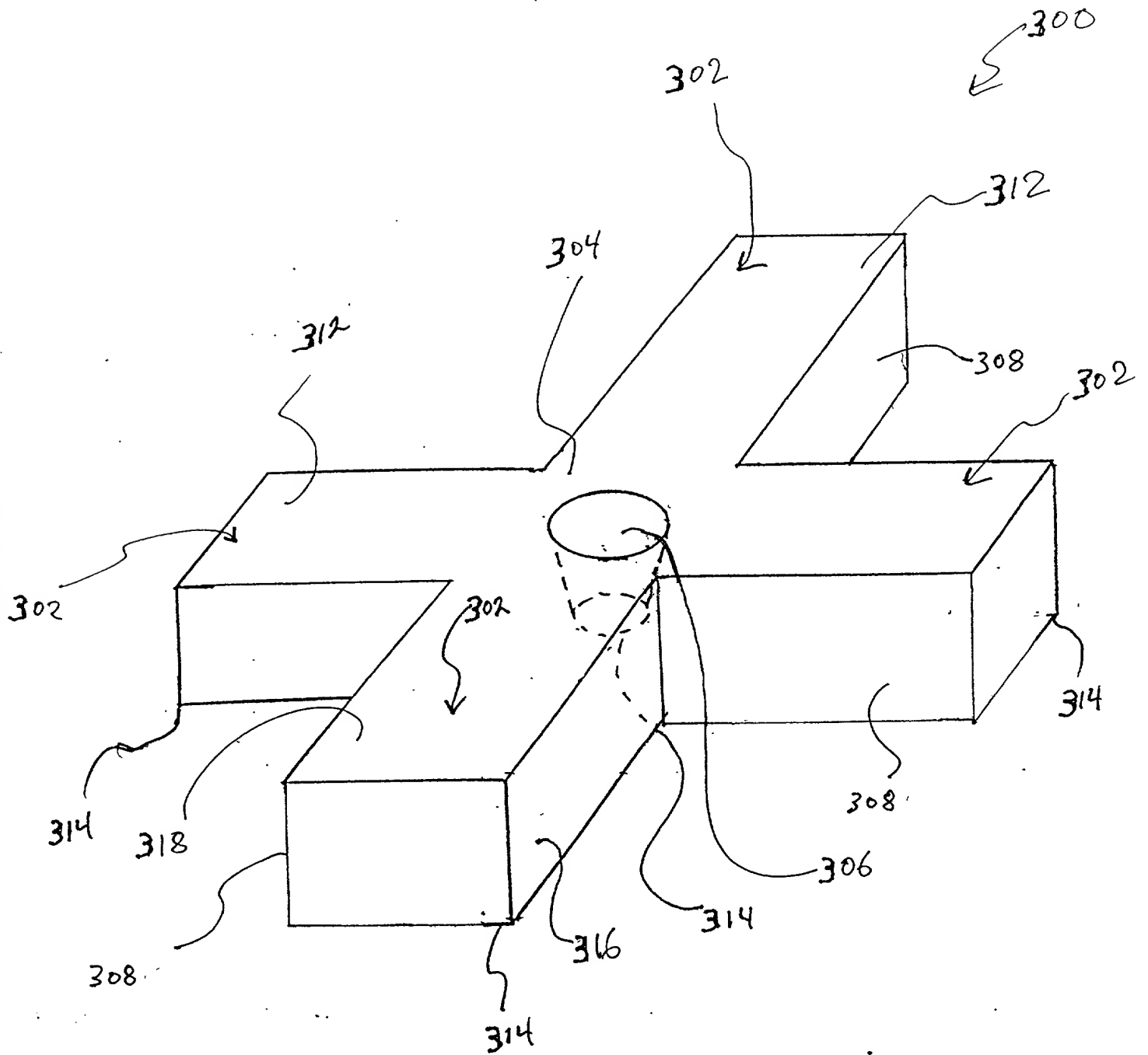


Fig. 4

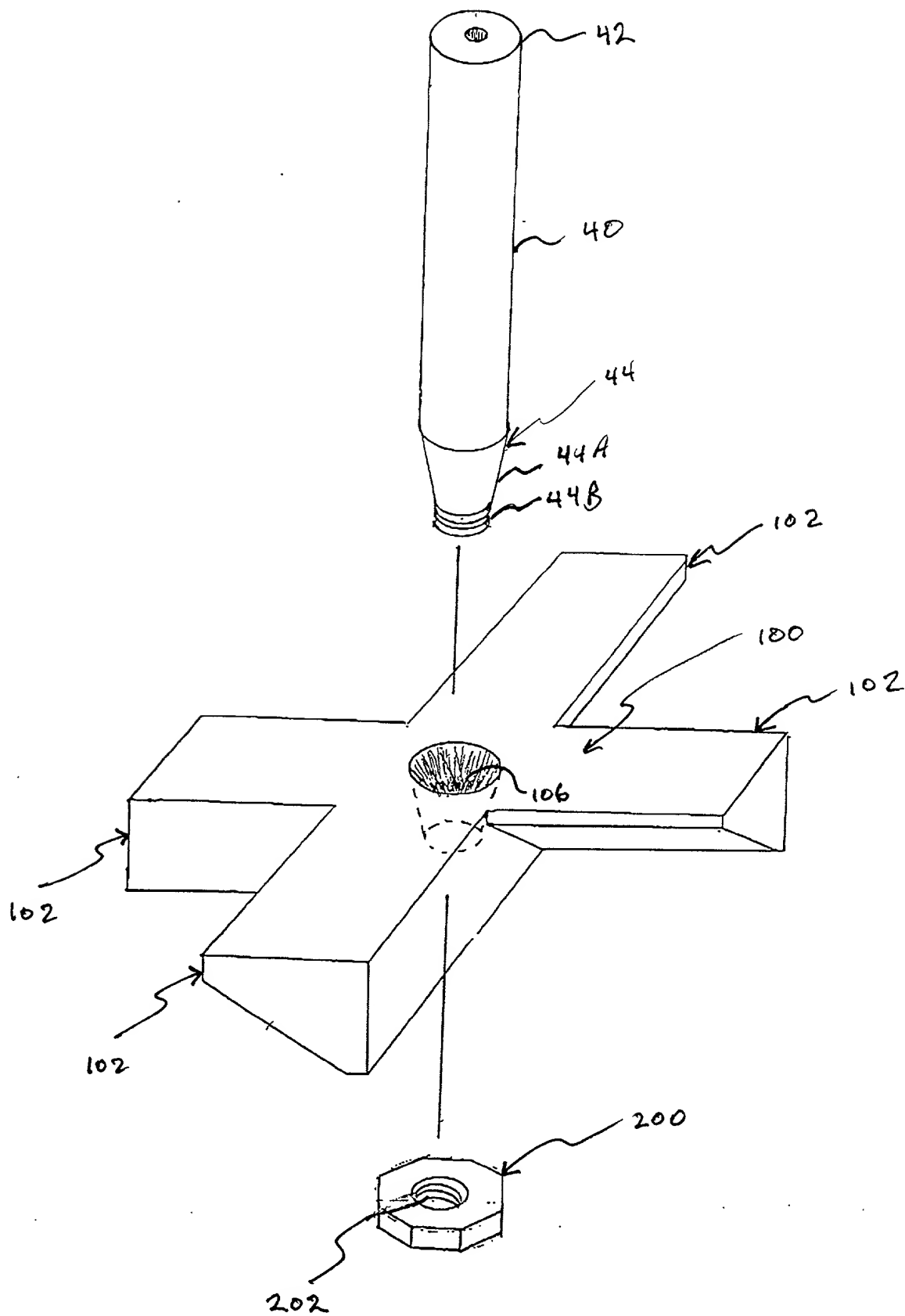


Fig. 5

A hand-drawn schematic diagram of a mechanical assembly. The diagram features a central vertical rectangular component labeled 40. This component is connected to a horizontal assembly. The horizontal assembly includes a central rectangular block labeled 200, which is flanked by two smaller rectangular blocks labeled 44A (on the left) and 44B (on the right). Above the central block 200, there is a horizontal rectangular component labeled 102. This component 102 is further divided into two sections: 108A on the left and 108B on the right. Dashed lines indicate internal structural features or hidden edges within the horizontal assembly. The entire assembly is labeled with a reference numeral 100.

Fig. 6